
Space Weather Technical Forecast

Issued on Wednesday, 22 November 2023 at 12:49 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Chance of R1 Radio Blackouts throughout. Chance of G1 Geomagnetic Storms, day 1 and day 4 (22 Nov and 25 Nov).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Low solar activity has been observed with C-class flares, the largest a C8.9 at 22/0628UTC from AR3492. There are currently ten sunspot groups on the visible disc, the majority of which are located in the eastern solar hemisphere. AR3492 is the largest group, located in the northeast and surrounded by several peripheral spots, each numbered individually. This spot group has shown new development in its trailing southern portion, with a small delta configuration. AR3490 to the west of AR3492 has also shown new growth and has been re-classified Dac/Beta. AR3489 in the southeast has shown some slight decay, especially in its trailing portion. The sole spot in the southwest, AR3498, is spreading and showing signs of decay. All other spots are simple and either stable or in decay at present.

No Earth-directed CMEs observed in the past 24 hours. A CME observed off the eastern limb late UTC on 21 Nov was modelled and is directed behind the Earth orbit, with no significant impacts expected. Another CME was observed in coronagraph imagery off the southeast limb following a filament eruption, beginning around 22/0630UTC, and is being modelled. However, this also looks directed off the Sun-Earth line and is not anticipated to have any significant impacts.

Solar Wind / Geomagnetic Activity: Solar wind parameters, as measured by ACE and DSCOVR at L1, have been indicative of a connection to CH73/+. Wind speeds rose from around 360 km/s to 500-590 km/s. The solar density was above average, peaking 22 ppcc at first, before gradually easing to below average levels in the second half of the period. The IMF was predominantly moderate, peaking at 15nT at 21/2218 UTC. The important north-south component (Bz) had several periods of consistently moderately negative/southward, peak -14nT at 21/2115 UTC. Phi angle was mainly positive (away from the Sun). Geomagnetic activity was largely Unsettled to Active (Kp 3 to 4), with G1/Minor Storm levels (Kp 5) 22/0300-0900UTC.

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux remained at Background levels.

GOES16 high energy (greater than 2MeV) electron flux remained at background levels. The associated 24-hour fluence has remained below the Active threshold (1e8 integrated pfu). The fluence observation at 22/0000UTC was 1.84e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: There is a daily Chance of M-class flares, mainly from current eastern solar hemisphere sunspot regions.

Solar Wind / Geomagnetic Activity: No Earth-directed CMEs feature in the forecast. Earth is currently connected to the high speed stream of coronal hole CH73/+. Elevated solar winds

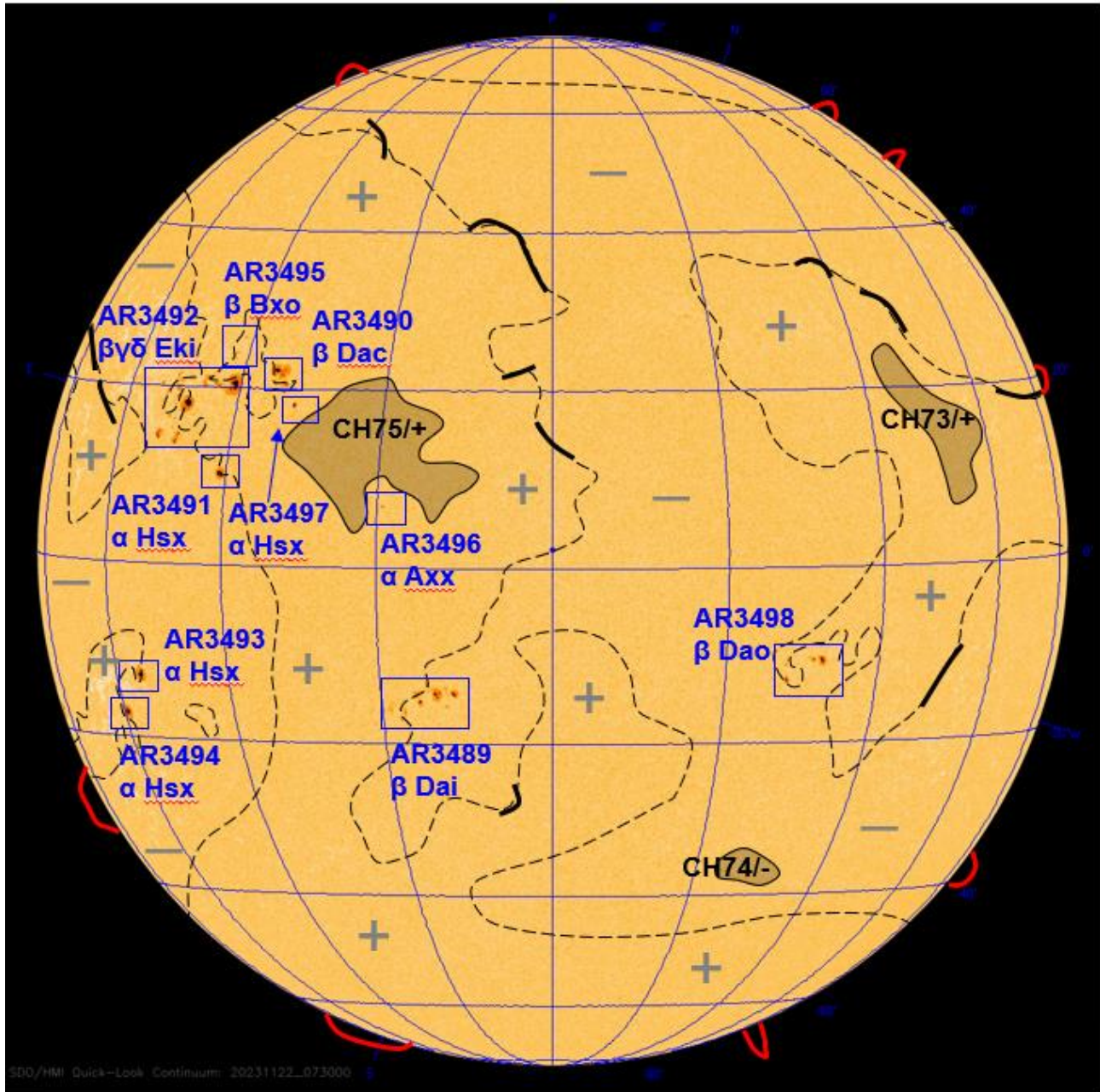
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gradually easing back to slightly elevated or background through days 2-4 (23 to 25 Nov). No further enhancements expected until the possible arrival of CH75/+ later on day 4 (25 Nov). Unsettled to Active with a Chance of a G1/Minor Storm is expected on Day 1 (22 Nov), gradually easing through days 2-4 (23-25 Nov) to become largely Quiet. The possible arrival of CH75/+ later on day 4 (25 Nov) brings a chance of G1/Minor Storm intervals to end the period.

Energetic Particles / Solar Radiation: GOES16 high energy proton flux is expected to remain at Background levels.

GOES16 high energy electron flux is expected to be background to moderate initially, before perhaps rising from day 2 (23 Nov). The associated 24-hour electron fluence will most likely remain below the Active ($1e8$ integrated pfu) level in this four-day period, but with a risk of breaching the Active threshold days 3 and 4 (24/25 Nov).

Figure 1. Solar Analysis Valid 22/0800UTC.



Key: Filament ____, Prominence ____, Magnetic Field Line - - -, Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α - β - $\beta\gamma$ - $\beta\gamma\delta$ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

No Earth-directed CMEs currently feature in the forecast.

Earth is currently connected to the high speed stream of coronal hole CH73/+, with elevated solar winds continuing through day 1 (22 Nov) before gradually easing back to slightly elevated or background levels in the coming days. No further enhancements are then expected until the arrival of CH75/+ later on day 4 (25 Nov) or perhaps beyond the forecast period. On the previous rotation, this coronal hole was a much larger and darker feature that it appears currently, with speeds reaching 570 km/s and a prolonged period at elevated. Geomagnetic activity on the previous rotation was Kp 3-5. Therefore it is thought that similar if not a slightly muted version of events will take place upon the connection of the CH75/+ on this rotation. Speeds of up to 500-550 km/s are possible briefly.

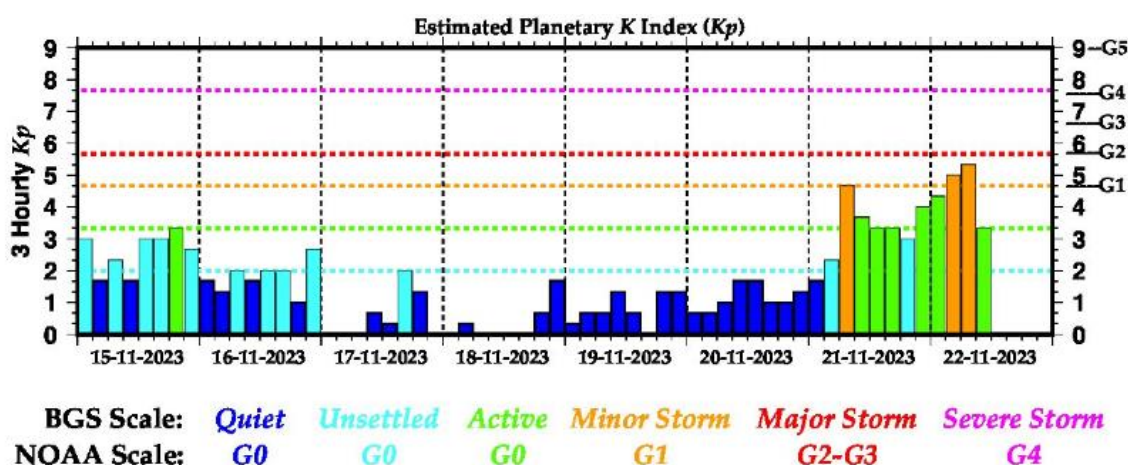
Unsettled to Active with a Chance of a G1/Minor Storm is expected on Day 1 (22 Nov), gradually easing through days 2-4 (23-25 Nov) to become largely Quiet. The possible arrival of CH75/+ later on day 4 (25 Nov) brings a chance of G1/Minor Storm intervals to end the period.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	Yes	40	5	1	30
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

None expected.

Figure 2: BGS plot of planetary K index shows the increased geomagnetic activity in the past 24 hours.



Radio Blackouts - X-Ray Flares:

There are currently ten sunspot groups on the visible disc, the majority of which are located in the eastern solar hemisphere. AR3492 is the largest group, located in the northeast and surrounded by several peripheral spots, each numbered individually. This spot group has shown new development in its trailing southern portion, with a small delta configuration forming. AR3490 to the west of AR3492 has also shown new growth and has been re-classified Dac/Beta. AR3489 in the southeast has shown some slight decay, especially in its trailing portion. The sole spot in the southwest, AR3498, is spreading and showing signs of decay. All other spots are simple and either stable or in decay at present.

All considered, there is a continued Chance of M-class flares given the complex eastern solar hemisphere. There is the potential for more regions arriving around the eastern limb, though there is little evidence to suggest any region currently has increased activity. X-class flares are now also considered a daily Slight Chance given the potential for development.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	50	50	50	50
Very Active	R3 to R5 X Class	No	5	5	5	5

Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 is currently at Background levels.

Two large and complex regions on the eastern solar hemisphere have resulted in an above background risk of a S1/Minor Solar Radiation Storm. This risk remains nominal until any significant groups approach the western solar hemisphere.

Radiation Storms	Level (cm ⁻² sr ⁻¹ s ⁻¹)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	5	5	5	5
Very Active	≥ S3 *	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = cm⁻²sr⁻¹s⁻¹)

High Energy Electrons Event ($\geq 2\text{MeV}$):

Electron flux levels are expected to continue fluctuating between Normal Background and Moderate flux levels initially, being suppressed by the current coronal hole high speed stream. Later in the period flux levels may increase with a chance of the High 1000 pfu threshold being breached near the diurnal maximum, as coronal hole high speed stream influences wane. A further suppression is possible toward the very end of the forecast period, or perhaps slightly after, due to the arrival of the HSS of CH75/+.

Fluence levels are expected to remain below the $1\text{e}8$ Active threshold initially, the risk of this being breached increases during day 3 and 4 (Nov 24/25) as CH HSS effects wane and the electron belts recover after a period of charging.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	No	1	10	30	40
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1

Figure 3: MOSWOC REFM latest output.

